U.S. Department of Transportation

National Highway Traffic Safety Administration

Addressing the Safety Issues Related to Younger and Older Drivers

A Report to Congress
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on the
Research Agenda
of the
National Highway Traffic
Safety Administration

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Issues Related to Younger and Older Drivers

The Committee on Appropriations of the U.S. Senate, in Senate Report 102-148, requested the National Highway Traffic Safety Administration (NHTSA) to prepare a report on the Agency's research agenda addressing the safety issues of younger and older drivers. In response to this request, this report covers a variety of issues that affect younger and older drivers, presents a brief overview of past Agency efforts, and provides NHTSA's planned research agenda for each group separately. In this report, "younger" refers to ages 15 through 24, while "older" refers to ages 65 and above.

NHTSA conducts behavioral research to increase safety by improving safe driving actions, and performs biomechanics and human-factors research to increase safety by improving vehicles. Behavioral programs are used by the States and national organizations. Engineering results are implemented through Agency rulemaking actions for vehicle manufacturers.

The Agency has long been aware of the problems of younger drivers and the special needs of older drivers. In developing program activities, NHTSA has formed working relationships with a variety of Federal, State, and private sector organizations, including the Federal Highway Administration, National Institute on Aging, Transportation Research Board, American Association of Motor Vehicle Administrators, State licensing and driver

education agencies, and the American Association of Retired Persons, among others.

Assessment of crash statistics indicates that young driver problems vastly exceed any other age group. On a per-mile basis, older drivers do have a greater fatality rate than other-aged drivers. But by any other measure, young drivers outnumber, out-travel, out-crash, and die more frequently than do older drivers. There are slight differences between younger and older drivers in the types of crashes they experience. For example, young drivers have more speeding and alcohol-related crashes. Older drivers have more right-of-way and turning crashes. Younger driver crashes are frequently caused by inexperience, poor judgment, and risk taking while older driver crashes are more often related to reductions in physical and cognitive capabilities of which the driver is unaware.

Research Agenda For Younger Drivers

Historically, the Agency has worked to improve the safety of young drivers through education and training, licensing procedures, enforcement, and adjudication. Within the recent past, the emphasis has been on alcohol, occupant protection, and community programs.

Future efforts will attempt to improve understanding of unsafe driving by younger drivers, including risk taking behavior, influences of youth culture, and pressure from peers. The Agency will develop programs, activities and procedures, including improved enforcement and adjudication procedures, develop educational materials designed for specific subpopulations of younger drivers, and involve parents to help build safe driving habits in their children. Evaluations will be conducted to assess the impact of programs intended to reduce crashes,

including provisional licensing and lower BAC limits for those under age 21.

In addition, research will assess the use of advanced technologies to reduce the crashes of younger drivers. Applications for technology include the use of driving simulators to gather detailed information on drivers' behavior in high risk situations and the use of warning systems to alert drivers to impending dangers.

Research Agenda For Older Drivers

More than a decade ago, the Agency developed profiles of older driver crashes and recommended educational and licensing practices. NHTSA worked with the American Association of Motor Vehicle Administrators in developing guidelines for the States to use when dealing with driving problems that may be related to aging. Unfortunately, many of these efforts lacked detailed information on the difficulties caused by aging, including the loss of cognitive abilities, and the relationship of these problems to safe driving practices.

In the future, the Agency's efforts will focus on identifying and analyzing research data linking declining physical and mental capabilities of older individuals to their driving safety. Following these activities, NHTSA will recommend appropriate driving practices for persons with various conditions and develop information to assist them in making safe driving choices (including restricting when and where one drives). Additionally, the Agency will develop guidelines for families, medical practitioners, traffic enforcement, and licensing agencies to identify those older individuals who have driving problems. Agency efforts will also develop enhanced driver education and training program elements (e.g., to improve performance at intersections). NHTSA will

work to cultivate licensing and enforcement policies that protect the public's safety while maintaining the mobility of older drivers, including improved procedures and practices for problem drivers. NHTSA will continue to work with other Federal, State, and private organizations to stimulate research and a better understanding of the issues affecting the safety and mobility of older drivers.

NHTSA will also assess the use of improved technologies and vehicle crashworthiness characteristics. For example, crash data will be used to improve understanding of the injuries sustained by older occupants because of their increased frailty, including an evaluation of current occupant restraint systems. NHTSA will also investigate the possible role of advanced technologies to prevent crashes typical of older drivers. It is important to determine that technologies arising from Intelligent Vehicle & Highway Systems (IVHS) do not, in fact, overload the decision-making and informational capacities of older drivers.

Foreword

Anyone who has purchased automobile insurance for a driver under 25 years of age knows that many drivers in this age group are substantially over-represented in motor-vehicle crashes. Just about any way you look at younger drivers, whether on the basis of their numbers in the population, numbers of licensed drivers, or number of miles they drive annually, their crash rates are higher than other age groups. Not only do young drivers have more crashes than other age groups, they receive more than their share of citations for traffic violations. While not all younger drivers are unsafe drivers, many younger drivers pose safety problems that are obvious to most observers.

Many people believe that older drivers are a menace on the road, especially when they find themselves behind an older person driving slower than other traffic. These opinions can only be strengthened by news and feature-program coverage of tragic events in which an older driver was responsible for multiple deaths. But these events, though tragic, are rare. Drivers over 75, like younger drivers, are involved in more crashes per mile driven than drivers in any other age group. After the age of about 60, drivers and passengers are increasingly likely to die as a result of crash injuries because they are more frail than younger persons. This is true even though the number of crashes per licensed driver declines with age. While not all older drivers are safe drivers, safety problems posed by older drivers are less obvious and are often different from what many people believe.

Even though younger and older drivers share the distinction of having more crashes per mile driven than other age groups, the problems posed by these two groups stem from different origins and are manifested in different ways. And, perhaps more important, the

magnitudes of the problems presented by each group are vastly different.

These differences hold major implications for NHTSA's research program. While the magnitude of the older-driver problem is relatively small, potential solutions are well defined and simple to achieve. Although younger drivers present the most serious problems, the potential solutions are diverse and difficult to achieve.

As requested by the Committee, this report presents NHTSA's research agenda for addressing the issues related to the safety of younger and older drivers. Chapter 1 provides a summary of the issues related to younger and older drivers. Chapters 2 and 3 report on NHTSA's research program on younger and older drivers, respectively. Each of these chapters summarizes the status of work done to date; outlines the problems that currently remain; and describes the research actions needed to address those problems.

The Agency regards each of the projects or study areas described in the report to be essential for reaching our safety objectives for these age groups. However, the scheduling of the work will depend on available funding.

For the purposes of this report, the terms "young driver" or "younger driver" refer to drivers aged 15 through 24 years of age, while "youngest drivers" refers to those 15 through 19 years of age. "Older drivers" refers to drivers aged 65 years and older, while "oldest drivers" refers to those 75 years of age and older.

Issues Related to Younger and Older Drivers

The National Highway Traffic Safety Administration (NHTSA) has had a long-standing interest in improving the safety of both younger and older drivers, and in recent years has revitalized its interest in improving the safety of these groups.

NHTSA's Research Approach

NHTSA's approach to dealing with the problems of younger and older drivers proceeds on two fronts. First, each of these age groups is addressed in dedicated research projects that focus on physical and behavioral problems or practices. Second, younger and older drivers are treated as part of the continuum of the overall driver population in research that focuses on specific safety issues. The Agency's research and rulemaking activities focus on underlying traits responsible for the crash experience, not just using age *per se* as a discriminating variable.

NHTSA's research efforts on behalf of younger and older drivers may also be characterized by the ultimate goals of those efforts. The Agency conducts behavioral research to improve safe driving actions through such avenues as increasing knowledge and changing attitudes. It also conducts biomechanics and human-factors research to improve safety performance of vehicles through increased crashworthiness and improved crash-avoidance design features. Since vehicle improvements generally benefit occupants of all ages, behavioral research tends to

be more focused on specific age groups than vehicle-oriented research.

The Agency's behavioral research findings are incorporated into model safety programs and disseminated through published guidelines or reports of demonstration programs and program evaluations. States and communities are encouraged to adopt these model programs and implement them through their own legislative or program actions. The findings of the vehicle-oriented research are implemented through Agency rulemaking actions, which require vehicle manufacturers to comply.

Congressional Direction

This report on NHTSA's research agenda for addressing the safety issues of younger and older drivers was requested by the Committee on Appropriations of the U.S. Senate in Senate Report 102-148, which contained the following language:

> The Transportation Research Board report entitled "Safety Research for a Changing Highway Environment" carefully documents the challenge to highway safety posed by both the older and younger populations. As the report notes, the high involvement rate of older drivers in crashes (on a mileage-driven basis) is second only to those of drivers under the age of 25. Although NHTSA has important programs focused on each of these populations, the Committee seeks to enhance these efforts. Consequently, the Committee requests that NHTSA submit a report detailing its research agenda on topics specifically addressing the unique safety issues related to the older and younger driver.

NHTSA Planning Documents

NHTSA has long been aware of the special needs of younger and older drivers. Accordingly, the Agency developed safety plans addressing each of these special populations some time ago. As information accrues and needs change, these plans are updated and revised. The request for this report came at a time when the Agency is extensively revising each of these plans. This section briefly summarizes the existing planning documents.

Young Adult Highway Safety Plan

NHTSA's existing plan for road users aged 15 through 24 describes Agency program and research activities that address the highway safety issues prevalent among young drivers. This plan was first published in 1990.

The purpose of the NHTSA Young Adult Highway Safety Plan was to create an organized and focused approach to the population most at risk on our nation's highways: the driver under the age of 25. The Plan represented an integrated multi-disciplinary approach to a complicated traffic safety problem.

The young adult program was built upon a model initially developed as part of the Agency's anti-drunk-driving program. This model addressed the young adult highway safety problem in the areas of enforcement, adjudication, supervision, legislation, licensing, school-based programs, school-based extra-curricular programs, community based programs, and work-place based programs. These approaches were directed at the following priority areas: alcohol and other drugs, occupant protection, driver licensing, and motorcycles.

The output from this approach resulted in a presentation of (1) programs focused on a single issue; (2) comprehensive programs focused on two or more issues;

and (3) research and development activities. This research effort is intended to identify attitudes and behaviors characteristic of young adults to aid us in developing increasingly effective strategies for dealing with this population segment.

Many of the long-term research activities described in the Plan have been completed or have provided sufficient new information in the area of problem identification. Some projects described have been completed and new ones have been initiated. The Agency is currently revising this Plan to reflect accumulated progress and to accommodate the findings of completed activities. The revision will be completed during Fiscal Year 1993.

Traffic Safety Plan for Older Persons

NHTSA's Traffic Safety Plan for Older Persons addresses drivers, vehicle occupants, and pedestrians. The Agency developed the Plan in 1988 in response to recommendations in the Transportation Research Board's (TRB) Special Report #218, *Transportation in an Aging Society*. The Plan was developed to provide a comprehensive, coordinated program for improving the safety of older persons, while achieving a balance between safety and mobility.

NHTSA's Plan responded to the TRB report's recommendations and provided details of other work deemed necessary to improve the safety of older persons. It called for conducting research in problem identification, occupant protection, driver licensing, pedestrian safety, consumer information and vehicle safety.

NHTSA has completed many of the activities described in the Plan and conducted additional problem-definition activities, including co-sponsoring an international conference on research needs of older drivers. The results of these activities produced new knowledge about older-driver problems that suggested improved ways of addressing both safety and mobility issues. This research has significantly refined the older person traffic safety

issues and provided information to older person groups in both driving and pedestrian areas.

The Plan was designed to encourage close working relationships with other Federal agencies, the States, and additional concerned groups. While implementing the Plan, NHTSA has established lines of coordination across both State and Federal government agencies and private-sector groups. These connections have stimulated and guided research activities by other organizations well beyond the level that this Agency would be able to support.

The 1988 Plan for older persons is undergoing a major revision, and is scheduled to be completed during Fiscal Year 1993.

Characteristics of Younger and Older Drivers

The foundation of all traffic safety research is a thorough analysis of relevant data to identify problem areas and define populations needing special attention. The appropriateness and effectiveness of countermeasure development rests on this foundation. This section summarizes the Agency's findings regarding the level of crash involvement of younger and older drivers, and characteristics of the crashes that differentiate between the two age groups. Additionally, this section presents information on differences in performance abilities that distinguish the two groups.

Involvement in Crashes

An evaluation of the relative magnitudes of the crash problems contributed by younger and older drivers indicates that younger-driver problems vastly exceed older-driver problems. Figures 1 through 7 summarize crash data from NHTSA and Federal Highway Administration (FHWA) sources.

Figures 1 and 2 show, respectively, the number of drivers and the distance that they travel by age group. The similar shape of these two curves shows that the mileage traveled by each age group is closely related to the number of drivers in the age group. In 1990 there were slightly more than 26 million licensed drivers, ages 15 through 24, and about 22 million licensed drivers, 65 years of age or older. Although younger drivers only slightly outnumber older drivers (16 percent to 13 percent of the population of licensed drivers, respectively), the younger group drove more than twice as many miles as the older group.

Figure 1. Number of Licensed Drivers by Age Group

Number of Licensed Drivers

Millions of Drivers
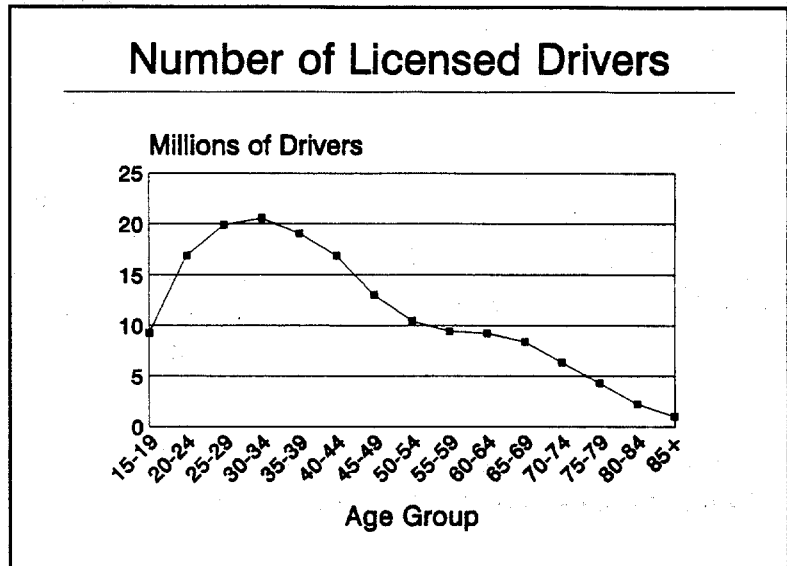
Age Group

Figure 2. Total Miles of Travel by Age Group

Total Miles of Travel

Millions of Miles

Age Group
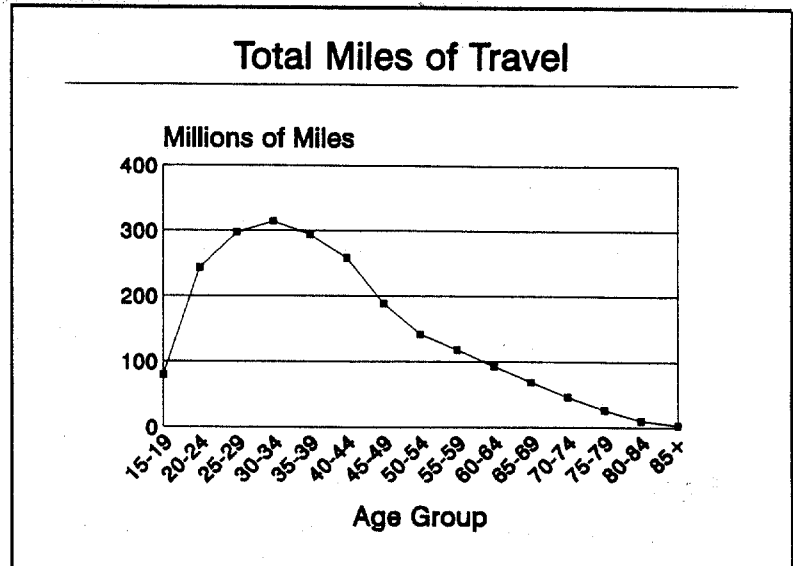
Figures 3 and 4 show, respectively, the number of drivers in reported crashes and the number of fatalities resulting from those crashes. The shapes of these two curves are also nearly parallel, showing that the relationship between crashes and fatalities is roughly the

Figure 3. Number of Drivers in Reported Crashes by Age Group

Reported Crashes

Thousands of Drivers in Crashes

Age Group
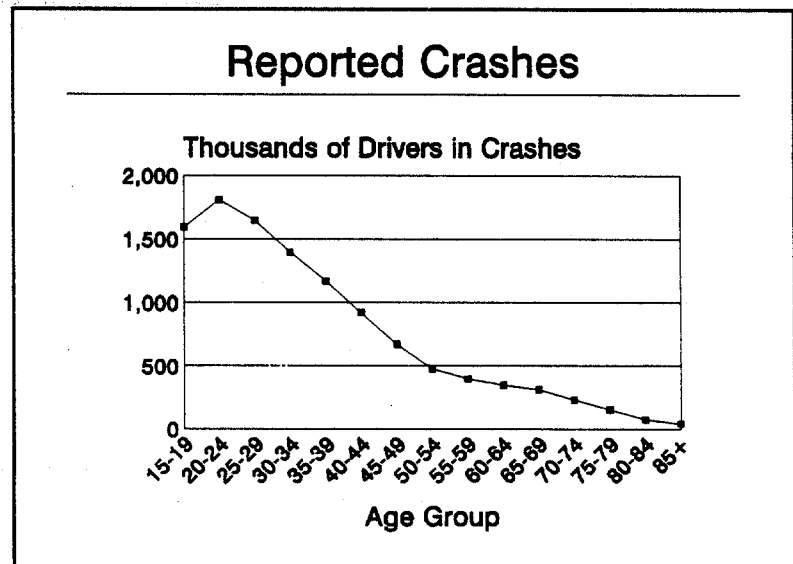
same for all but the older drivers. Younger drivers were involved in four times as many reported crashes as the older group. They also were involved in three times as many fatal crashes as older drivers. Compared with older drivers, more than twice as many younger drivers died.

Figure 4. Number of Driver Fatalities by Age Group

Driver Fatalities

Thousands of Fatalities

Age Group

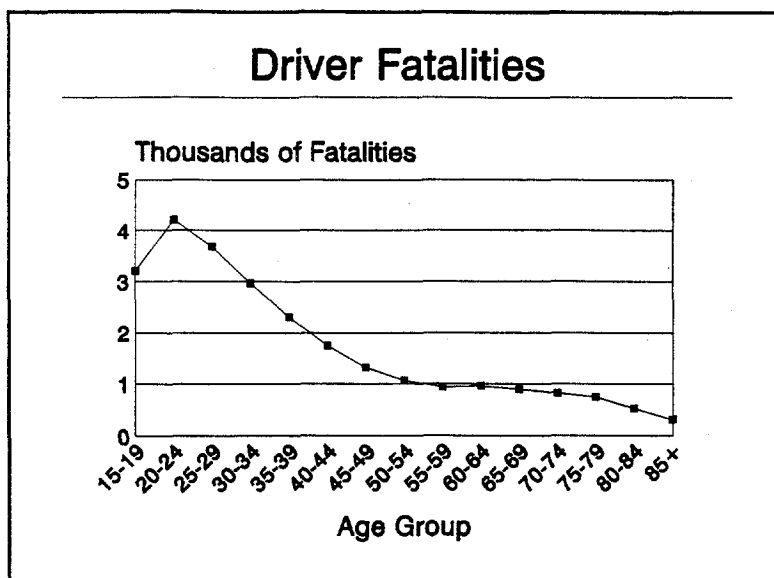Figure 5 shows that after the number of crashes is adjusted for the number of licensed drivers in the age group, younger drivers are considerably more likely to be involved in a crash than are older drivers. In fact, the **per-person** crash involvement rate decreases as age increases until drivers reach 85 or more years of age. Even this age group has a per-driver crash rate lower than drivers younger than 50 years of age.

Figure 5. Crash Involvement Rate
per Thousand Licensed Drivers by
Age Group

Crash Involvement Rate

Crashes per 1000 Licensed Drivers
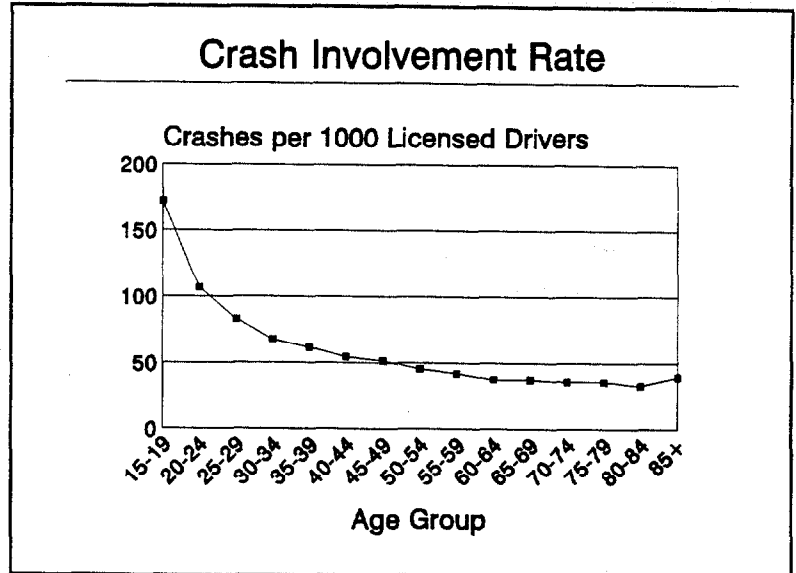
While the **per-person** rates reflect a smaller proportion of older drivers involved in crashes than younger drivers, adjusting the number of crashes by the total mileage traveled by members of each age group reveals a different pattern. Figure 6 shows the number of crashes per 100-million miles traveled. This curve indicates that the highest **per-mile** crash rates occur among the youngest and the oldest age groups. This demonstrates that an "average mile" driven by a member of one of these two groups is more dangerous than an "average mile" driven by a member of an intermediate age group.

However, since drivers at either end of the age range drive far fewer miles than those in between, researchers have questioned the equality of those "average miles" across age groups. Unlike younger and older drivers, drivers in the intermediate age groups travel a sizeable proportion of their annual miles on expressways and other inter-city roadways. These types of roads typically offer fewer hazards than do roads in urban areas. Most of the miles driven by younger and older drivers involve congested areas and heavy concentrations of intersections that offer relatively more opportunities for conflict with pedestrians and other vehicles.

Figure 6. Crash Involvement Rate per 100 Million Miles VMT by Age Group

Crash Involvement Rate

Crashes per 100 Million Miles VMT

Age Group
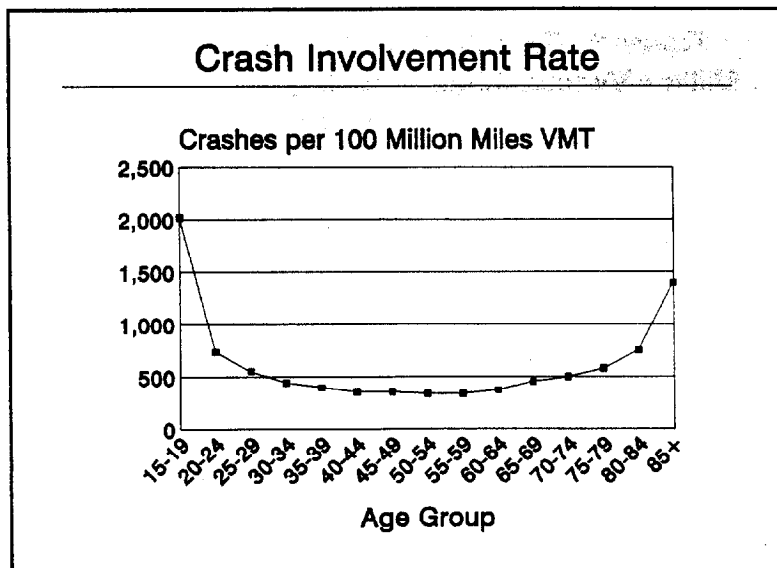
Fatality rates reveal that older drivers are at increased risk of dying, whether the rate is based on the number of licensed drivers (shown in Figure 7) or on the total vehicle miles traveled (shown in Figure 8).

Figure 7. Fatality Rate per Thousand Licensed Drivers by Age Group

Fatality Rate

Fatalities per 1000 Licensed Drivers
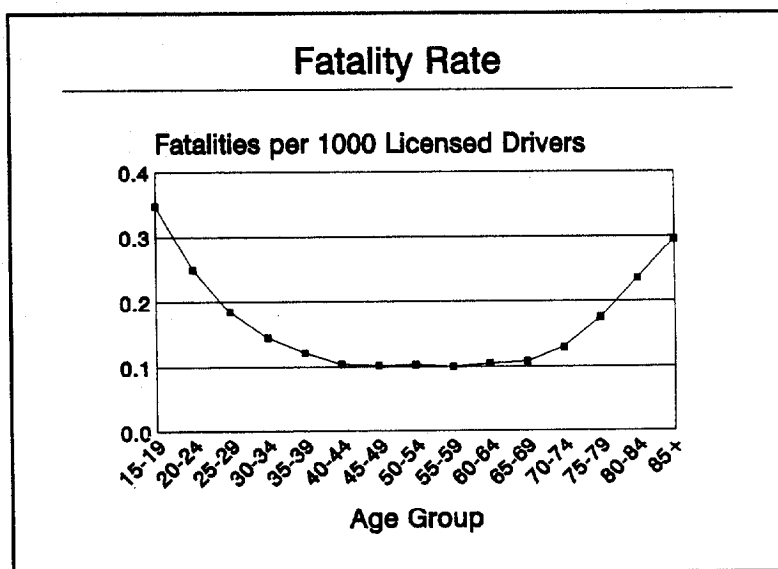
Age Group

Figure 8. Fatality Rate per 100 Million Vehicle Miles Traveled by Age Group

Fatality Rate
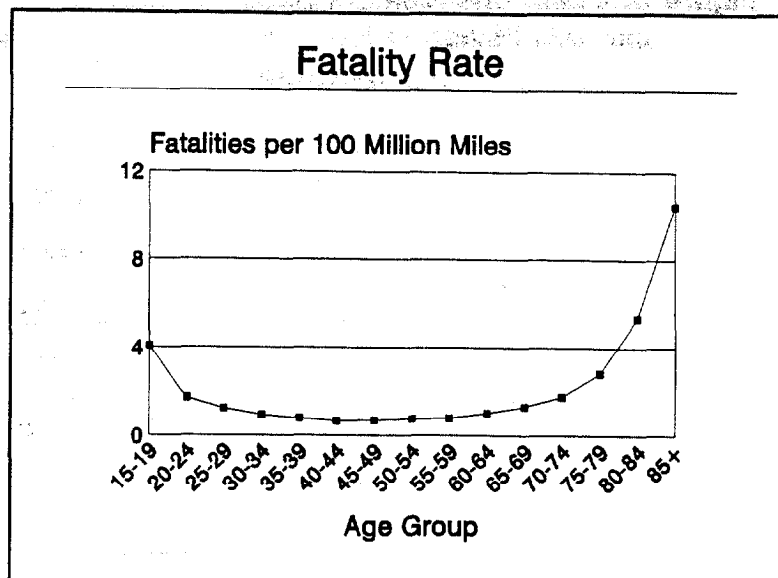
If drivers of any age were equally likely to die from crash injuries, then the shape of Figure 7 should be the same as Figure 5. This condition appears to hold for drivers below the age of 60 or so. However, drivers older than 60 years of age show increasing fatality rates, indicating that older drivers suffer more serious injuries in crashes than do younger drivers. This increase in driver fragility with age is shown more clearly by plotting the rate of fatalities per crash by age, as in Figure 9.

On a per-mile basis, older drivers have a greater fatality rate than other-aged drivers. But by any other measure, younger drivers outnumber, out-travel, out-crash, and out-die older drivers. However, once they are in a crash, older drivers are more than three times as likely to die than are younger drivers.

Figure 9. Driver Fragility by Age Group

Driver Fragility

Fatalities per 1000 Crashes
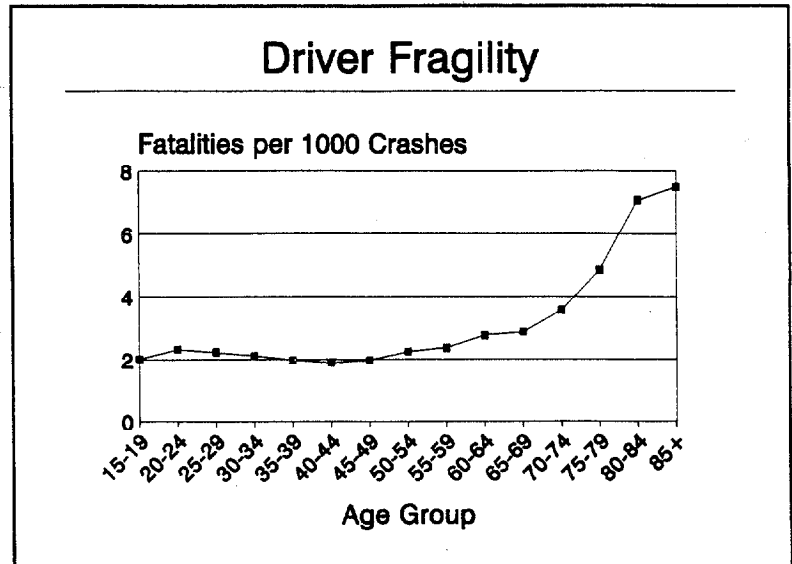
Age Group

Characteristics of Crashes

By looking at the *relative proportions* of involvement in different types of crashes, it is possible to gain some understanding of the differences and similarities between age groups, independent of the *absolute levels* of involvement. Analysis of police crash reports contained in NHTSA's 5-State Crash Avoidance Research Data File (CARDFILE) reveals some striking differences and some surprising similarities between the crash patterns of younger and older drivers.

Time of Day

Figure 10 shows the hour-by-hour pattern of crashes by drivers of different ages. The younger-driver crash pattern does not differ much from that of drivers between the ages of 25 and 64, showing the majority of crashes occurring between 7:00 a.m. and 8:00 p.m., with a small peak during the hours of morning rush hour and a large peak during evening rush hour. After 8:00 p.m., the number of crashes declines slowly to a minimum around 4:00 a.m. (for 25 to 64 year-old drivers) or 5:00 a.m. (for 15-24 year-old drivers). Older drivers, on the other hand, have few crashes between 8:00 p.m. and 7:00 a.m. The crash patterns of older drivers do not show rush-

hour peaks, but rather a slow increase in number from 7:00 a.m. to about 11:00 a.m., remaining flat until about 4:00 p.m., and slowly decreasing until around 8:00 p.m.

Figure 10. Number of Crashes by Time of Crash and Age Group

Time of Crash

Thousands of Crashes

Age Group
— 15-24
+ 25-64
* 65-74
— 75 +
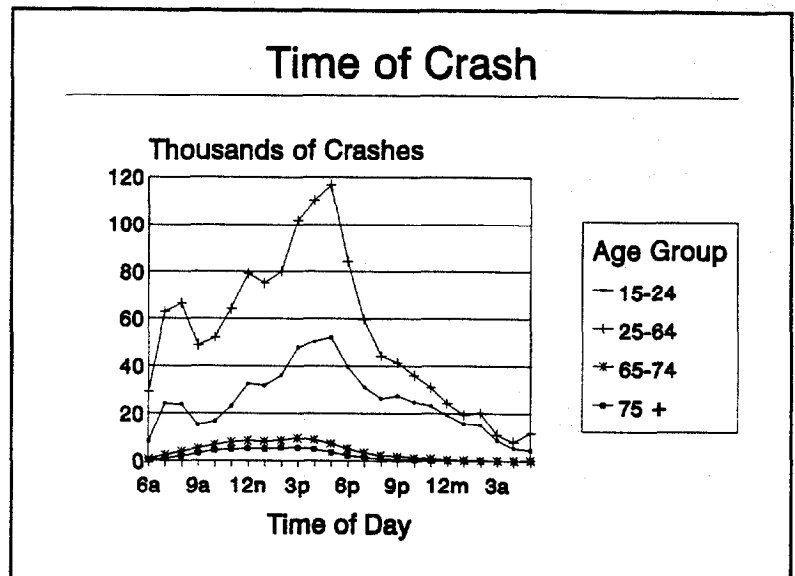
Time of Day

Light Conditions

The relationship between crashes and lighting parallel the patterns of crashes by time of day. Well over half of all crashes occur during daylight hours. However, the relative proportions of daylight and dark crashes vary with age, as shown in Figure 11. The 15 to 24 age group has one in three (33 percent) of their crashes after dark. Drivers between 25 and 64 have one in four (25 percent) crashes after dark. Drivers between 65 and 74 have one in eight (12.5 percent) of their crashes after dark, and the oldest group (75 years of age or older) has one in twelve (8.3 percent) crashes after dark. These results follow the reported driving habits of older drivers: they tend to drive less and less after dark as they get older. Many do not drive after dark at all.

Figure 11. Percent of Crashes by Light Conditions and Age Group

Light Conditions

Percent of Crashes

Legend: Dusk, Dawn, Dark/Lighted, Dark/Not Lighted, Day

Age Group: 15-24, 25-64, 65-74, 75 +
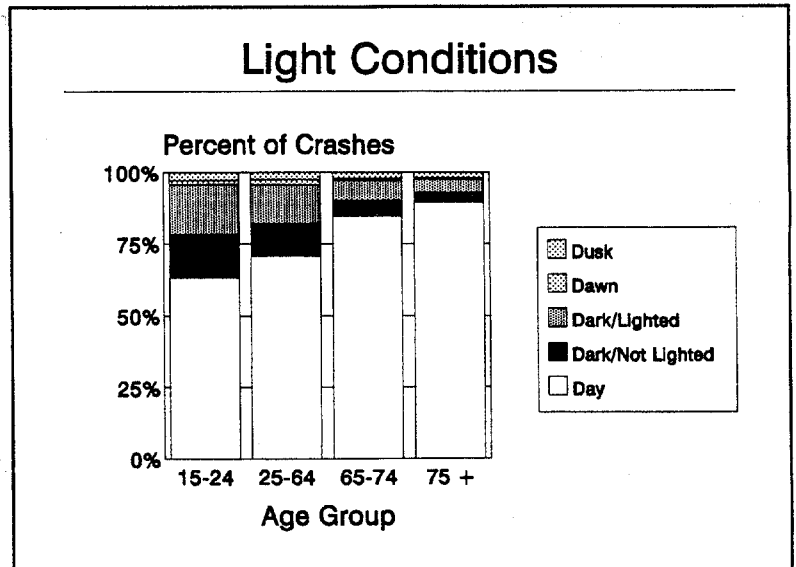
Crash Severity

Remarkably, the distribution of crash severity is almost identical across age groups, as shown in Figure 12. About 60 percent of all crashes involve property damage only; 22 to 23 percent involve possible injury; 12 percent non-incapacitating injury; 5 percent incapacitating injury; and fewer than one percent of crashes involve fatal injury. Among the fatal-injury crashes, the level of involvement increases with age, with 0.6 percent for drivers 15 to 64; 0.7 percent for drivers 65 to 74; and 0.9 percent for drivers 75 and older.

**Figure 12. Percent of Crashes by
Severity Level and Age Group**

Crash Severity

Percent of Crashes

- Fatal Inj
- Incap Inj
- Nonincap Inj
- Poss Inj
- Prop Damage

Age Group: 15-24, 25-64, 65-74, 75 +
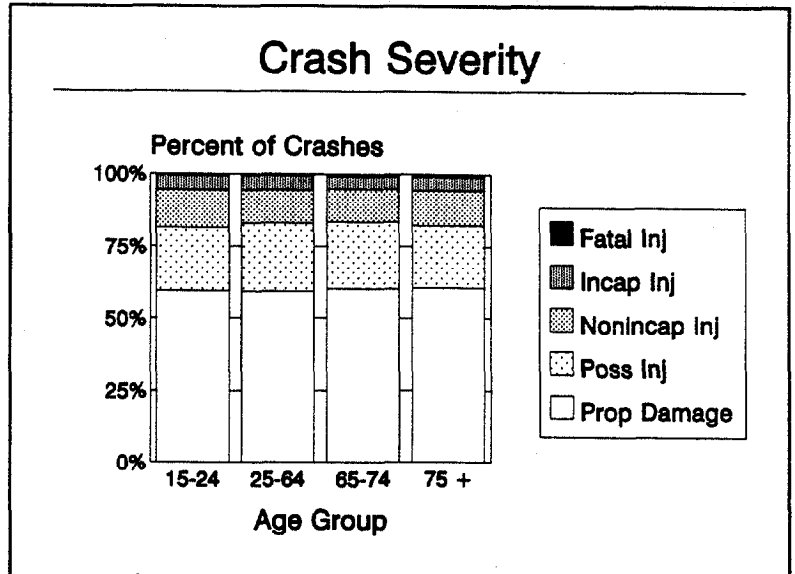
Number of Vehicles Involved

The majority of crashes involve two vehicles, regardless of drivers' age, as shown in Figure 13. Among younger drivers, two-vehicle crashes account for 68 percent of all crashes, compared with 71 percent of drivers 25 to 64,

**Figure 13. Percent of Crashes by
Number of Involved Vehicles and
Age Group**

Number of Vehicles

Percent of Crashes

- Four or More
- Three
- Two
- One

Age Group: 15-24, 25-64, 65-74, 75 +
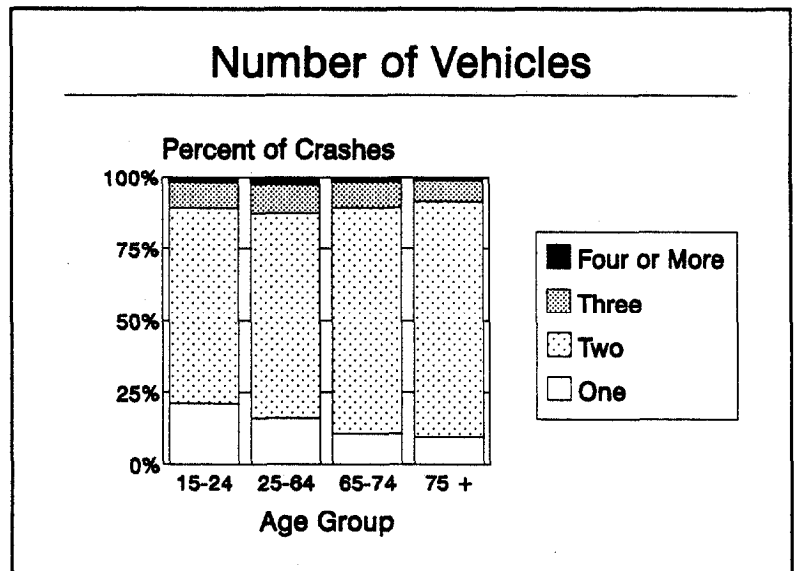
and 80 percent of drivers 65 and older. The percentage-point differences between age groups on two-vehicle crashes are largely made up in single-vehicle crashes. Proportions of single-vehicle crashes from the youngest to the oldest are 21 percent, 16 percent, and 10 percent, respectively.

Relationship to Intersection

Most crashes for all age groups occur at intersections, although the proportions are somewhat different for the different groups, as shown in Figure 14. About 50 percent of crashes of the youngest and middle groups occur at intersections, whereas about 60 percent of older drivers' crashes occur at intersections. Younger drivers show a greater tendency than other age groups to be involved in non-intersection crashes, with 15-24 age group showing 43 percent, the 25-64 group showing 41 percent, and the 65-74 group showing 31 percent.

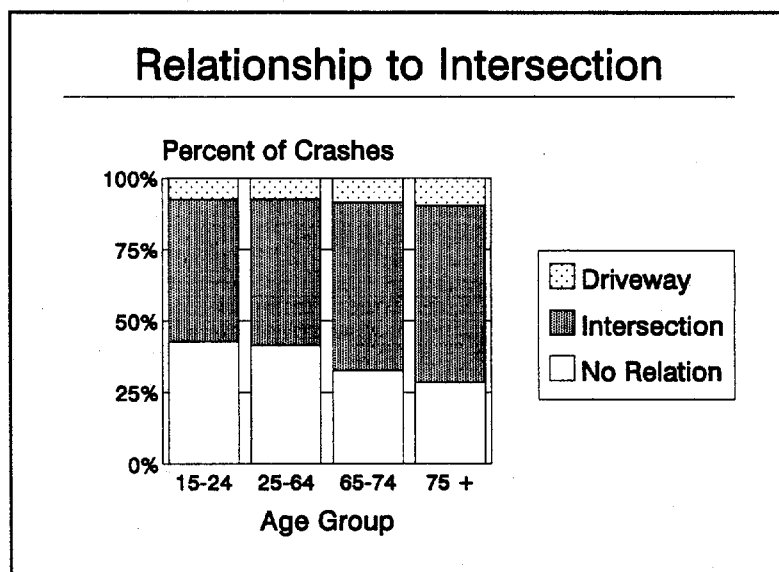**Figure 14. Percent of Crashes by Relationship to Intersection and Age Group**

Relationship to Intersection

Percent of Crashes

Driveway
Intersection
No Relation

15-24 25-64 65-74 75 +
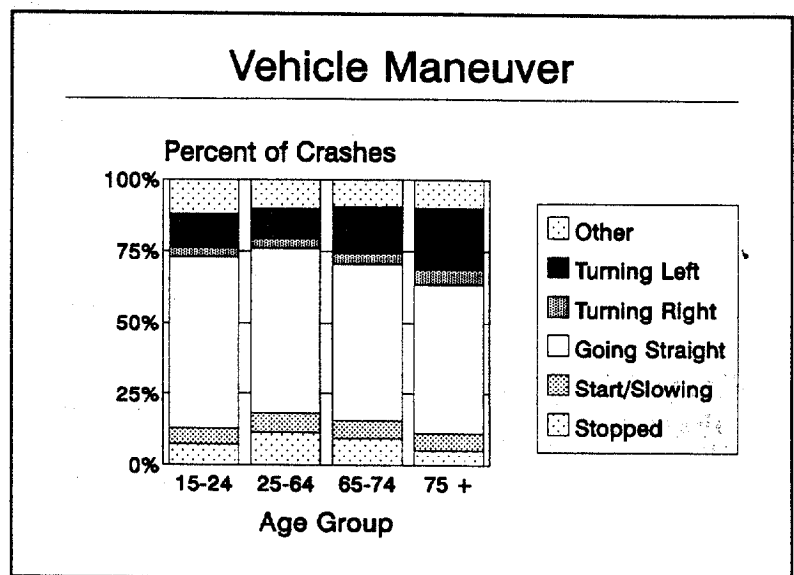
Age Group

Pre-crash Maneuver

More than half of the crashes of all age groups involve the vehicle going straight just prior to the crash, accounting for 59 percent of the youngest group's crashes, 57 percent of the middle group's crashes, and 53 percent of the oldest group's crashes. These proportions are shown in Figure 15. The most striking difference between the groups is in the

proportion of crashes involving left turning. While 11 percent of younger drivers' crashes involved left-turning, 17 percent of older drivers' crashes involved left-turning. Within the older driver group, the oldest drivers show the greatest proportion of crashes in this category, involving 16 percent of 65-74 year-old drivers' crashes and 21 percent of the crashes of drivers 75 years old or more.

Figure 15. Percent of Crashes by Vehicle Maneuver and Age Group

Vehicle Maneuver

Percent of Crashes

Legend: Other, Turning Left, Turning Right, Going Straight, Start/Slowing, Stopped

Age Group: 15-24, 25-64, 65-74, 75 +

Driver Error Excessive speed is the primary error in 15 percent of younger-driver crashes, but only in about 5 percent of older-driver crashes, as shown in Figure 16. Right-of-way violations are the primary error in 18 percent of older-driver crashes, but only in about 9 percent of younger-driver crashes. Older drivers also make more errors at signed or signalized intersections than do younger drivers: 14 percent and 9 percent respectively. Driver inattention, which includes falling asleep at the wheel, was about equally likely among younger and older drivers, accounting for slightly more than 5 percent of crashes in each group.

Figure 16. Percent of Crashes by Driver Error and Age Group
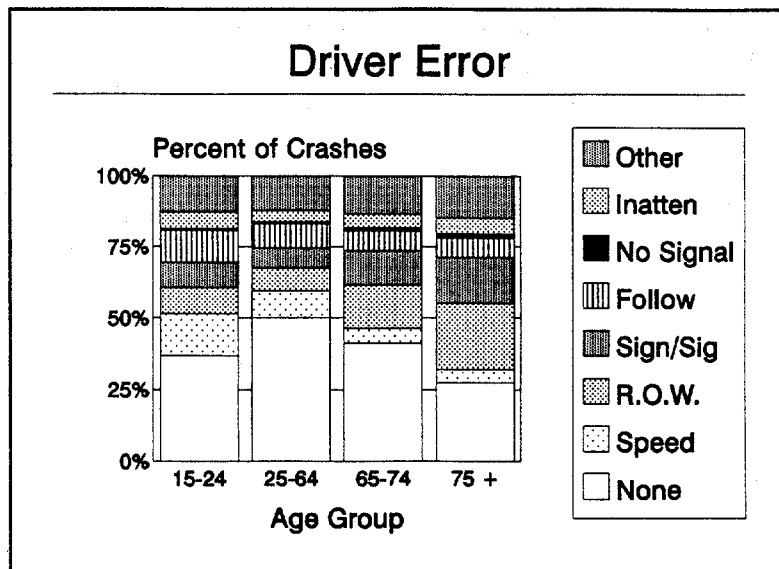
Alcohol Involvement

Blood Alcohol Concentrations (BAC) at or above .10 percent are detected in about 6.5 percent of crash-involved younger drivers. Drivers between 25 and 64 years of age also show BACs at or above .10 percent in 6.5 percent of their crashes. Older drivers, however, show BACs at or above .10 percent in less than 2 percent of their crashes. These relationships are shown in Figure 17.

Alcohol plays a much larger role in **fatal** crashes. One out of 10 fatal crashes in 1990 involved drivers or pedestrians with BACs between .01 and .09 percent, while 4 of 10 involved drivers or pedestrians with BACs at or above .10 percent. Twenty-seven percent of young drivers in fatal crashes had BACs at or above .10 percent, compared with 26 percent of drivers between 25 and 64, and 6 percent of drivers 65 years old or older.

Figure 17. Percent of Crashes by Driver Use of Alcohol or Drugs and Age Group

Driver Use of Alcohol or Drugs

Percent of Crashes

■ Alc/Drug
☐ No Alc/Drug

Age Group: 15-24, 25-64, 65-74, 75 +
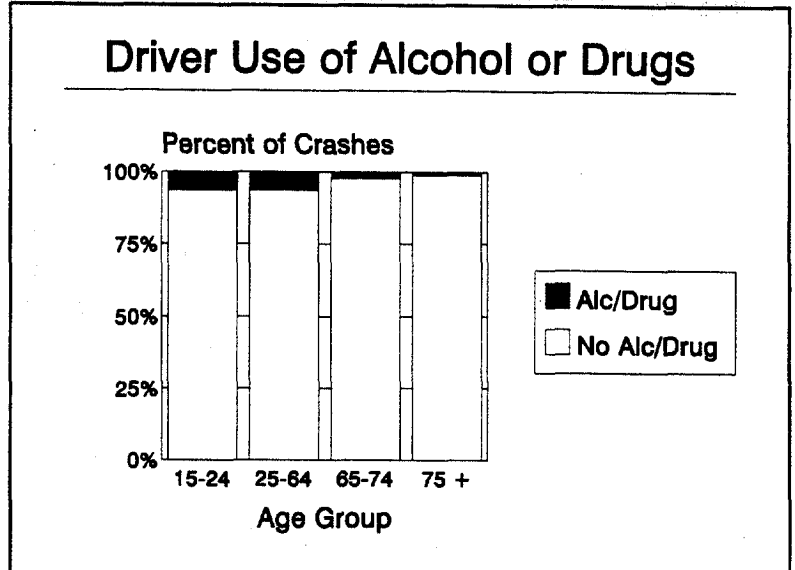
Sources of Risk for Younger Drivers: Problem Behaviors

The primary problems of drivers between 15 and 25 years of age appear to be related to lack of experience, immature judgment, and risk taking. Younger drivers have limited life experience to rely upon in developing responses to the driving environment.

Some researchers contend that younger persons, especially in the teen years, have a sense of immortality and invulnerability to danger that carries over into their driving behaviors. Younger drivers tend to believe that crashes only happen to others. Some younger individuals also tend to display other characteristics that foster unsafe driving. Younger drivers perceive risk differently than older drivers. A NHTSA study found that younger drivers rated speeding as less dangerous than did their more experienced counterparts. There also was evidence that young drivers saw themselves as more skillful than their peers, and that young drivers' increased familiarity with a driving location reduced their perception of danger in that situation. This was not found for more experienced drivers. The findings suggested that, relative to drivers over 25 years of age, young drivers associated lower risks with certain driving acts and

underestimated their personal risk of being involved in a crash.

Personality factors, particularly among males, may also contribute to the young driver problem. The literature includes references to over-expression of impulsiveness, daredevil driving, anger in traffic situations, and driving to let off steam after arguments. There also are weak but consistent correlations between various "anti-social" personality traits (more common among the young than other age groups) and higher crash rates.

Sources of Risk for Older Drivers: Declining Capabilities

The research literature confirms conventional knowledge about the effects of aging on cognitive, perceptual, and motor abilities.

Age-related changes in vision make it more difficult for older adults to accommodate to darkness, recognize objects under low lighting conditions, recover from glare, and search their environment. Virtually all behavior slows with age, with performance decrements being more pronounced as task complexity and cognitive demands increase. Making decisions becomes more difficult, as does changing a course of action once a commitment has been made. Memory deteriorates with age, although the decline in healthy adults is not as great as previously believed. Short-term memory, in particular, is affected by aging. While few studies linked cognitive declines specifically to driving abilities, it is clear that these kinds of changes in abilities could pose problems for drivers who experience them.

Experience and judgment are qualities that can contribute to compensating for slowed responses and sensory deficiencies. Evidence shows that most older drivers are aware of their changing abilities and adapt accordingly: making shorter trips totaling far fewer miles, and driving substantially less at night, in heavy traffic, and in bad weather. These self-regulated changes in exposure to risk largely account for the differences in crash characteristics between younger and older drivers.

Driving problems increase with the seriousness of certain medical conditions. To the extent that older individuals are aware of their conditions, they tend to limit their driving appropriately. But, if they are victims of conditions of which they cannot be aware, they appear not to limit their driving and are consequently exposed to greater crash risk. Cognitive disorders, such as Alzheimer's Disease and difficulties performing tasks that require processing of several sources of information are among the most serious of these latter conditions.

Older drivers' safety problems are exacerbated by increasing frailty. Drivers 75 years old or older are three times as likely to die in a crash than are 20 year old drivers.

Research Agenda For Younger Drivers

The primary safety issues related to drivers between the ages of 15 and 24 are inexperience, immaturity, and risk taking. Education and training have achieved limited demonstrated success in reducing the unsafe driving behaviors of young drivers. The apparent disregard for one's own personal safety appears to be a defining element of youth.

Effective methods to restrain impulsive, risky behaviors have traditionally concentrated on law enforcement, license restriction or denial, or other aversive controls. The effectiveness of these approaches is limited by the resources communities can devote to them.

The Agency's research and programmatic activities for younger drivers are based on the analyses of safety problems posed by this age group. The diversity of current research directions reflects the diversity of causes of and corrections for younger drivers' safety problems. This chapter includes a brief description of the Agency's previous research and programmatic activities and specifies the direction of future research on younger drivers. These activities are, for the most part, explorations of new approaches to dealing with younger driver problems. Although they are not as well defined as activities in a more mature research program, they hold tremendous potential for dealing with the safety problems of younger drivers.

Summary of Prior Research

Historically, NHTSA has pursued a multi-faceted approach towards reducing crashes among younger drivers. During the last twelve years, however, NHTSA's behavioral research activities related to younger drivers have focused almost exclusively upon alcohol and under-age drinking, with some attention to occupant-protection issues. The course of this effort is currently expanding to include many broader issues, including cultural norms, peer influence, and risk-taking attitudes.

In the past, the Agency has worked to improve highway safety among this population through institutional actions (e.g., education and training, licensing procedures, enforcement, and adjudication) based on increased understanding of individual beliefs, attitudes, and knowledge supporting highway safety. NHTSA has developed technical knowledge and materials to support these actions, as well as methods for disseminating the information and providing technical support to safety professionals and others.

The following paragraphs highlight the most significant of these activities.

Driver Education

One of NHTSA's earliest objectives was improving the education and training of new drivers. Seminal studies identified behaviors necessary to operate a passenger car, and assessed how critical each behavior was to driving. The Agency used this information to develop two model high-school driver-education curricula, which NHTSA implemented in the 1970's.

NHTSA evaluated a large-scale demonstration of the curricula conducted in Dekalb County, Georgia. Over a 3-year period, students were randomly assigned to one of the two curricula or to a no-training comparison group. Students' driving records over the next six years of driving demonstrated a six percent reduction in crashes among drivers in the standard education programs.

The reasons why driver-education courses seem to have had only limited success as a crash reduction program are unclear. Some safety professionals have suggested that shorter programs focusing on specific topics would be more effective than traditional courses. Others have suggested a two-phase driver education integrated with driving experience.

NHTSA also has developed and tested short instructional programs (modules) intended to supplement driver-education instruction. These modules reliably increased knowledge and improved self-reported safe driving. Unfortunately, these modules were introduced at a time when school-based driver-education courses were suffering cutbacks due to tight school budgets and were not widely implemented as designed. Other completed NHTSA projects include preliminary preparation of a curriculum to provide collision-avoidance skills.

Driver Licensing

The driver licensing system is the key to integrating new drivers safely into the highway network and limiting the driving of those who pose safety problems. In order to ensure that the Agency's research and program activities are well accepted among State driver-licensing agencies, NHTSA works closely with the American Association of Motor Vehicle Administrators (AAMVA).

Research in this area has produced a model driver-improvement (point) system for identifying problem drivers and provides remedial instruction or imposes sanctions based on the severity of offenses. This system has been adopted to some extent by many State licensing agencies.

Driver licenses provide youth with a measure of status and independence. They also present social opportunities and other benefits. Thus, youths are highly motivated to obtain a driver license and to keep it. Provisional licensing programs take advantage of these realities by prescribing certain requirements (e.g., lower BAC thresholds, nighttime restrictions, safety belt use, no violations, etc.) to which provisional licensees must adhere in order to acquire and retain a regular driver license.

In conjunction with the AAMVA, NHTSA developed a model provisional-licensing program designed to ease novice drivers under the age of 18 into the driving environment. Provisional licensing enables these young drivers to gain knowledge, skill, and experience over time under controlled conditions.

Parts of the model program were implemented by the States of Maryland, California, and Oregon. Evaluations of these programs showed reduction in crashes and traffic convictions among the affected age group. However, despite the existence of the NHTSA/AAMVA model program, and evidence that provisional licensing can be effective, States have been reluctant to initiate such programs.

Attitudes

The young driver highway safety problem stems from more than a lack of knowledge or skills. Consequently, NHTSA has endeavored to identify and understand other characteristics of young drivers that contribute to the problem, so that appropriate countermeasures can be developed. The Agency has conducted preliminary research on risk-taking to determine how younger drivers perceive risk differently from more experienced drivers, and in what ways their risk choices differ from other drivers.

Other NHTSA research has examined norms and attitudes of adolescents and young adults related to alcohol use and driving. Respondents reported strong societal influences supporting drinking and driving after

drinking. Respondents also lacked information on risk factors, assessing degree of impairment, and consequences of drinking and driving.

Recent national telephone surveys on drinking and driving issues conducted for NHTSA will provide additional information on attitudes, knowledge, and behaviors of this age group. Results of this research have not yet been released.

Enforcement

General deterrence is an important part of the Agency's young driver program. Recently completed NHTSA research explored the problem of low arrests and citations for underage drinking drivers, and identified barriers to effective enforcement of drinking and driving laws as they pertain to these drivers. Further, the study examined enforcement programs that appear to be successful in addressing the problem, identified general principles for effective enforcement of drinking and driving laws among underage drinkers, and developed an assessment package to assist police agencies in implementing effective enforcement practices.

Raising the minimum drinking age (MDA) for alcohol to 21 has led to substantial reductions in crash-related fatalities among young drivers. NHTSA has conducted research to identify feasible, acceptable, and effective programs to deter adolescent drinking in support of the 21 MDA. Experts and youths participating in the study largely agreed on which programs would be most effective. They included: (1) programs that suspend the driver license of underage drinkers or postpone the age at which individuals become eligible to receive a license; and (2) improvements in the design and distribution of driver licenses in order to reduce the use of fraudulent identification to obtain alcohol.

The Agency also has evaluated the effects of a Maryland law restricting persons under age 21 from driving with any detectable amount of alcohol in their system (current devices cannot detect BACs below .02 percent). The study found a reduction in the average number of under-

21 crash-involved drivers judged "had been drinking" by the police associated with the implementation of the law. Further, the effectiveness of the law was enhanced by the addition of a public information and education (PI&E) campaign that emphasized the possible penalties for violation of the regulation.

While the majority of the Agency's research on enforcement for young drivers has focused on alcohol, other efforts have been directed at other unsafe behaviors, most notably driving above posted speed limits.

Adjudication

NHTSA has been co-sponsoring workshops with judges to help them deal in a more effective manner with impaired driving issues both in the courts and in their communities. NHTSA also has been conducting research to validate an assessment instrument for determining if young drivers charged with violating drinking and driving laws would benefit from enrollment in alcohol-treatment programs.

Motorcycle Safety

Improving skills and protection of motorcyclists has been another important NHTSA objective. The problem in the motorcycle area is principally centered among young drivers. Motorcycle safety research has been concentrated in three major areas: operator testing and licensing, rider education, and helmet use, but has also included studies related to conspicuity enhancement, alcohol safety, and moped safety. A great deal of the motorcycle research has been done in conjunction with the Motorcycle Safety Foundation.

NHTSA research has provided much of the current knowledge on the nature of the motorcycle crash problem through a benchmark crash analysis study that identified causal factors of motorcycle crashes, and identified countermeasures for crash and injury prevention. More recent NHTSA research includes development of visual cues for police to detect DWI motorcyclists.

The bulk of current NHTSA efforts in the motorcycle area are support activities through cooperative agreements and grants. Current youth-specific demonstration grants include (1) a court referral program that requires violators to successfully complete a motorcycle rider education course; and (2) a program to encourage enrollment of younger cyclists in rider education courses, encourage use of protective gear, increase enforcement of DWI laws among motorcyclists, and reduce the number of younger motorcyclists riding without a proper license.

Community Programs

The Agency has sponsored a number of efforts to focus attention on younger drivers. In 1988, the Agency held regional youth traffic safety meetings attended by local, State and Federal officials. These meetings asked for recommendations on how to support more joint activities between alcohol, safety belt, speed control and other safety programs to reach the common target audience of younger drivers. Participants identified a need to convene a national gathering of leaders from each State who are responsible for youth program areas. In July 1989, NHTSA cosponsored a Forum on Youth Traffic Safety Initiatives in Washington, D.C., attended by traffic safety experts, government officials, representatives from the private sector, and members of the youth traffic safety research community. These individuals developed an Agenda for Action, since published by NHTSA.

The Forum's published recommendations are organized according to the "Youth Traffic Safety Model." This model outlines nine important components in any community's system for reducing traffic fatalities among this age group: school-based programs, enforcement programs, extracurricular programs, licensing programs, community-based programs, adjudication programs, work-based programs, supervision programs, and legislative initiatives.

NHTSA has used its grant program to encourage implementation of such comprehensive programs in the

States and has supported efforts by national organizations to address the underage drinking problem. Additionally, NHTSA has developed resource materials to assist implementation.

Directions for Current and Future Research

Although significant progress has been made in recent years, motor vehicle crashes continue as a major contributor to deaths and injuries among young adults. Explanations posed for the heavy toll include their inexperience as drivers, their risk-taking behavior, aspects of the youth culture that influence driving, and pressure from peers. Yet the reasons underlying unsafe driving by younger drivers are not well understood. Moreover, research to date generally has shown only punitive or restrictive measures to be effective in reducing crashes and injuries among young drivers. There is a lack of knowledge about how to elicit safer driving through education and positive incentives.

Problem Identification

The following research projects are necessary to obtain fundamental information required to develop program strategies.

Develop Model for Understanding Unsafe Driving Practices by Younger Drivers

Research suggests that young drivers often are ignorant of important aspects of risky driving behaviors. Yet the young adult crash problem stems from more than a lack of knowledge among drivers. Norms, perceptions, cognitive abilities, attitudes, culture, lifestyle, and situational pressures all seem to contribute to decisions regarding driving. Most of these factors imply a motivational component to unsafe driving, i.e., people do what they are doing for reasons that have little to do with information or skills deficits. This research will establish what is currently known about risk-taking by young people in a variety of health-behavior areas,

extract common elements, and describe the relationships between these elements and risky behavior. As part of this effort, NHTSA plans to sponsor or co-sponsor a national symposium on risk-taking.

Assess Impact of Advanced Technology Information Systems on Risk-taking Behavior

Risk taking appears to play a far greater role in the crashes of younger drivers than in those of middle-aged or older drivers. Driving research using high-fidelity simulators, such as the planned National Advanced Driving Simulator (NADS), permits the gathering of detailed information on driver behavior and performance under simulated high-risk driving scenarios. Such scenarios cannot be addressed using conventional research methods (e.g., instrumented vehicles) due to safety concerns. A NHTSA program on crash avoidance warning systems will identify opportunities for crash prevention through the use of warning systems, and will determine how warning signals (e.g., "Approaching curve too fast!") can be effectively presented to most drivers.

Some researchers have hypothesized that drivers increase their risky behaviors in response to improvements in highway or vehicle safety, thereby partially or even fully negating the positive effects of crash countermeasures. Accordingly, NHTSA will assess the effects of prospective crash-avoidance technologies on driver risk taking.

Determine Utility of Addressing Specific Sub-groups of Young Drivers

While there is reason to develop countermeasures for all young adults, due to generalized risk in that age group, all young drivers are not equivalent risk candidates. The question arises as to which subgroups merit special attention due to higher levels of unsafe driving or unique countermeasure needs. For example, the literature shows males to be far more at-risk than females, although females appear to be driving more like males in recent years.

This research will obtain data on young adults who engage in unsafe driving practices to identify target subgroups, determine geographic distribution, clarify patterns of unsafe driving practices, and determine other

characteristics important to understanding and addressing the problem. National data collection will include the conduct of telephone surveys in the alcohol and occupant protection areas. In the alcohol area, the survey will help define strategic target groups. The occupant protection survey will focus on knowledge of and attitudes toward occupant protection issues, but will also collect data on driving habits to identify groups appropriate for targeting. Both surveys will query the total adult population, but will collect data from sufficient numbers of younger drivers to allow adequate analysis. Additional information may be acquired through focus-group interviews to explore particular issues in more depth, in order to obtain sufficient understanding of complex issues to permit development of appropriate countermeasure strategies.

A separate research project will be collecting and analyzing data concerning young employees ages 16 through 24. The project will focus on young employees who are employed full- or part-time and are not included in school-based countermeasure programs. The project will identify the extent to which young employees are at greater risk than their older counterparts, and will assist NHTSA in developing programs to reduce those risks.

Establish Feasibility of Advanced Technology to Reduce Crashes

In addition to its ongoing basic research on driver performance and crash causation, NHTSA has underway or in planning a series of programs to determine how, and how effectively, advanced technology crash avoidance countermeasure concepts can reduce crashes. NHTSA's near-term programs will develop performance specifications for systems dealing with rear-end, intersection/crossing path, lane change/merging/backing, and single-vehicle roadway departure crashes. (Later programs will develop performance specifications for night/vision enhancement systems and rapid response emergency medical service "Mayday" systems.) The single-vehicle roadway departure and emergency medical service projects will be highly relevant to younger drivers as they are over-represented in these crashes.

Current NHTSA-funded research focuses on developing methods of detecting reduced performance associated with drowsiness and fatigue, a problem in which younger drivers are somewhat over-involved, relative to other age groups. Later, this research will focus on erratic driving behaviors and performance, areas particularly relevant to younger driver crashes.

Determine Role of Dynamic Vehicle Cues on Driver Performance

Driving involves a continuous interaction of the driver with his or her vehicle and the roadway environment. Visual cues from the roadway are obviously of paramount importance. Less obvious is the importance of motion cues from within the driver (e.g., kinesthetic, vestibular) and certain vehicle response cues (e.g., body roll, apparent oversteer/understeer). IVHS (Intelligent Vehicle and Highway System) technologies present the possibility that such cues may be manipulated in the future to provide enhanced feedback to the driver to decrease the likelihood of vehicle loss-of-control. The nature of the feedback may even be adjustable based on factors such as driver age or risk. This research program will determine the effects of various combinations of cues on driver performance.

Program Development

The following research projects focus on developing strategies for addressing problem areas and generating suitable countermeasure elements to address specific issues.

Tailor Program Strategies to the Needs and Characteristics of Specific Target Populations

An important ingredient to reducing motor vehicle crashes and injuries is developing strategies that effectively counter underlying reasons for engaging in unsafe driving behaviors. To the extent that such reasons reflect cultural or group norms, countermeasures should be tailored to the needs of specific target groups. Moreover, groups may differ in their receptivity to varying information messages or to varying methods for inducing behavior change.

This research program will determine educational and other techniques that will be effective with different population subgroups. For example, NHTSA's norms

research program currently is working on developing techniques to elicit anti-DWI behavior from drivers, including younger drivers. This and other projects will be used to develop approaches, strategies, materials, and programs applicable to specific groups.

Develop Methods and Materials to Improve Enforcement and Adjudication Involving Younger Drivers

Safety legislation and its enforcement have been crucial contributors to the gains made in highway safety. Yet there is significant room for improvement in enforcement and adjudication. This is particularly true in dealing with younger drivers, whose levels of arrests and citations for certain violations (e.g., DUI/DWI among drivers younger than 21 years of age) fall below what one would expect from their contribution to the motor vehicle crash problem. Developing improved enforcement techniques, plus developing materials to assist the police and courts in enforcing the laws, should add to the safety benefits already accrued from current deterrence efforts.

This effort will determine the types of sanctions that would be most effective in deterring youth from proscribed driving behaviors and develop methods and materials to improve enforcement of highway safety laws for younger drivers. For example, NHTSA is funding an inter-agency agreement with the Department of Justice to (1) examine issues of enforcement, adjudication, and prosecution of drinking and driving laws among underage drinking drivers; (2) develop technical assistance materials to support alcohol enforcement efforts with underage drinking drivers; and (3) set up demonstration sites to test the materials. NHTSA also has awarded grants to the National Council of Juvenile and Family Court Judges (NCJFCJ) and the International Association of Chiefs of Police (IACP) to conduct a series of statewide workshops for their respective constituencies on youth adjudication and enforcement issues.

Other planned research includes studies of the use of enforcement technology, such as passive alcohol sensors and roadside videotaping, that may have relevance to younger drivers.

Determine Bases for Motorcycle Operation With Improper License

Crash data show substantial numbers of riders not properly licensed to operate the motorcycle. This evidence suggests that many riders may not have the requisite skills and training to operate safely in traffic. This research effort will determine reasons for improper licensure so that strategies may be developed to increase proper licensure among young motorcyclists. Promising procedures will be evaluated.

Develop Methods for Involving Parents in Building Safe Driving Habits in Their Children

Parents have great potential to influence their children, being experienced drivers who, for better or worse, provide models of "acceptable" driving behavior. Parents could also monitor and shape the performance of their offspring. However, they are rarely employed in programmatic efforts to build safe driving habits among younger drivers. NHTSA previously conducted research to assess the feasibility of developing programs to assist parents in preventing drinking and driving by their children. The results suggested some barriers to parental involvement in traffic safety programs that would need to be overcome.

Research on how best to do so must wait until we know which youth subgroups are most important to target. It may well be that some of the target groups will consist of persons for whom there is little hope for obtaining effective parental influence. There is a need first to identify the target groups and gain an understanding of them. Consequently, this research must follow identification of target groups in order to make decisions about whom to target for parental involvement and determine effective methods for eliciting this involvement.

Program Evaluation

The following research projects examine existing programs to document their implementation processes or assess the extent to which they meet their outcome objectives.

Evaluate Implementation and Effectiveness of Safety Programs Directed Toward Younger Drivers

While numerous highway safety programs are implemented across the nation, relatively few undergo rigorous evaluation. Thus, there is a great deal of activity but not much information on what works. Even with an area such as provisional licensing, where there is evidence of effectiveness, questions persist about how best to implement the program and which components may be most effective.

NHTSA's research agenda includes evaluation of countermeasure activities to document their effectiveness and/or determine the best ways of implementing the prevention method. For example, lower BAC limits for drivers under age 21 will receive further study through crash data analyses conducted for States having the lower limits, as well as States not having lower limits. NHTSA also will be evaluating provisional licensing in those States which have implemented a provisional system that contains a majority of the components recommended in the NHTSA/AAMVA model program. The evaluations will include an attempt to assess individual system components.

Other planned activities include evaluation of improved motorcycle licensing procedures and programs and field test of programs that support 21 MDA legislation.

Evaluate Regional Underage Drinking Program

Underage drinking poses a significant threat to the safety of younger drivers. NHTSA awarded a grant in FY 92 to the Washington Regional Alcohol Program (WRAP) to conduct a regional effort to combat this problem. The three year project involves the development of an action plan for the Washington, DC region, its implementation, and evaluation. The first year of the grant involved the collection of baseline data to assess the nature of the problem and what should be done to address it. In addition, the project has initiated a process evaluation of the regional effort, and has been working to identify appropriate outcome measures for an evaluation of program effectiveness

Research Agenda for Older Drivers

The primary safety issue facing older drivers is how to adapt driving practices to accommodate declining functional capabilities while still maintaining necessary mobility. NHTSA's research agenda focuses on identifying those capabilities that are critical to safety, determining the driving practices that are appropriate for those capabilities, developing information for assisting individuals in making the proper choices, and cultivating licensing and enforcement policies that protect public safety while maintaining the mobility of older drivers.

In contrast to the research needs of younger drivers, the research needed to ensure the safety and mobility of older drivers has been well defined. This chapter includes a brief description of the Agency's previous research and programmatic activities and specifies the direction of future research on older drivers.

Summary of Prior Research

NHTSA has had a research interest in the safety of older drivers for many years. The Agency initiated a series of projects in the mid-1970's to improve the safety of older drivers. These projects focused on identifying the problems of older drivers, with an emphasis on attempting to understand the role of declining health and ways to inform older drivers and assess their driving capabilities.

Medical Limitations

In the early 1980's, NHTSA sponsored an in-depth study of heart-attack victims that found, contrary to expectation, that those with myocardial infarction actually had a better safety record than their age, sex, and regionally-matched controls. The study also indicated that very few of those who had a heart attack reported it on their driver license application at time of renewal.

Agency research also investigated potential improvements in the assessment of driver visual capabilities. This research identified a number of complex visual problems related to safe driving performance. Unfortunately, due to the nature of the tests and limitations of the technology available at that time, tests of these complex visual skills were not sufficiently reliable to establish new vision standards. This research provided evidence that most common visual problems, such as poor visual acuity, appeared not to have an adverse affect on driving safety. Most drivers suffering from poor acuity are aware of their problems and may adapt their driving accordingly.

While certain medical conditions are apparent to those that contract them, others are not. Drivers with conditions in the former group seem to adapt their driving habits appropriately. However, individuals suffering from conditions in the latter group seem not to adjust their driving to compensate for their declining capabilities. These conditions include dementias and certain other cognitive problems involving attending to simultaneous events.

Driver Licensing

More than a decade ago, the Agency developed profiles of older-driver crashes and recommended licensing practices for older drivers. Working with the American Association of Motor Vehicle Administrators (AAMVA), NHTSA developed a series of guidelines designed to assist the States in dealing with an array of driving problems. Among the guidelines were those that dealt with functional ability, certification of license examiners and a model driver screening and evaluation program. These programs were based upon what practitioners and

the research consultants thought were the best available practices. Unfortunately, basic epidemiological data needed to develop the policy guidelines did not exist at that time.

Retraining

The Agency worked with the private sector to develop and evaluate retraining programs for mature drivers. Driver licensing research led to development of a driver manual to help older drivers become familiar with and take appropriate action about their declining capabilities. Older people did accept, learn and retain the written information. However, an evaluation of the crash and violation records of those receiving the information failed to show any significant reduction when compared with a control group.

The Agency developed and distributed special informational materials on occupant protection for older drivers, studied how older persons obtain information, and identified potential distributors of safety information to older drivers and pedestrians.

Scientific Knowledge Base

NHTSA staff were actively involved with the Transportation Research Board (TRB) study on *Transportation in an Aging Society: Improving Mobility and Safety for Older Persons*, Special Report 218.

NHTSA's most recent research efforts on behalf of the older driver stem from the Agency's 1988 *Traffic Safety Plan for Older Persons*, published in response to the recommendations of the TRB report on aging. This plan outlines a number of research and development activities spread across several areas, including problem identification, occupant protection, driver licensing, pedestrians, consumer information, crash avoidance, and crashworthiness.

Following the Plan, the Agency conducted a number of research, development, and outreach activities. In order to complete the intended problem-identification objectives, Agency staff conducted an extensive literature

review on aging and driving and an analysis of existing national data.

In 1989, the Agency convened a conference to establish a benchmark on current knowledge about aging and driving performance in order to define the research and developments needed to improve the safety and mobility of older drivers. This conference, cosponsored by the National Institute on Aging (NIA), the Federal Highway Administration (FHWA), and the Centers for Disease Control (CDC), was attended by more than 200 internationally known gerontological specialists in medical and behavioral research and applications.

Following one of the recommendations of the conference attendees, Agency staff were instrumental in establishing a TRB Task Force on the safety and mobility of older drivers. The purpose of this ongoing task force is to provide a forum for discussing older-driver research issues by individuals representing diverse disciplines and developing a coordinated set of research problem statements for the use of Federal and State government agencies and private-sector organizations. This Task Force co-sponsored a conference on assessing driver competency.

In 1989 and 1991, NHTSA established interagency agreements with the NIA. NIA had funded a group of longitudinal studies of functional abilities of older persons. The interagency agreement permitted NHTSA to obtain driving information from older persons in two of their study sites, rural Iowa and New Haven, Connecticut. This teamwork permitted the investigation of the role of older drivers' medical conditions and functional ability in their driving safety and personal mobility. This research has led to a much better understanding of the changing driving patterns associated with medical conditions and functional limitations.

What We Know

The research with NIA confirms earlier hypotheses that most older drivers seem to be taking appropriate steps in controlling when and where they drive based upon their

declining capabilities. However, there appears to be certain groups of older drivers who do not appropriately limit their driving because they are unaware of their declining capabilities. Drivers in this latter group are especially difficult to identify, as the procedures currently necessary to detect the medical conditions thought to be associated with driving problems are time consuming, complex, and expensive. Simple methods proposed to regulate problem older drivers also tend to place unnecessary limitations on drivers who do not pose safety problems.

It also appears that older women are much more likely to stop driving than are men of the same age, and they give "lack of confidence" as their main reason for quitting. Results indicate that it is much easier to predict when an individual is likely to stop driving voluntarily than it is to predict their involvement with traffic violations.

Directions for Current and Future Research

This section describes NHTSA's research program for addressing safety problems unique to older drivers. It does not address the Agency's research on older vehicle occupants or pedestrians.

Problem Identification

Much of what we need to do is to understand the changes that occur with aging as they relate to driving and provide information to drivers to allow them to evaluate those changes. The following research projects are necessary to obtain fundamental information required to develop program strategies.

Establish Crash Risk for Various Medical/Functional Conditions

Sufficient epidemiologic data now exist to begin to establish statistical relationships between some medical conditions and driving problems. Accordingly, this research effort will determine the conditions under which

older drivers pose a threat to public safety and thus need to be identified and controlled. This study will establish the statistical link between crash risk, moving violations, and various physical and mental conditions. It will also identify the extent to which individuals with conditions that affect driving performance correctly modify their behavior and drive safely. The results of this study will serve as a basis for developing informational, licensing, and enforcement programs.

Determine the Conditions Under Which Driving by Older Persons Should be Regulated

Recent literature indicates that most older drivers compensate for their limitations in what appears to be an appropriate manner. A major function of law-enforcement and driver-licensing agencies will be to identify and regulate those drivers who do **not** self-regulate, i.e., those who continue to drive in situations in which they pose safety risks. To assist licensing agencies in establishing appropriate regulatory approaches, the Agency will determine the characteristics of drivers that do not adequately self-regulate and the conditions, if any, under which they may be able to drive while preserving safety.

Document Mobility Consequences of Giving Up Driving

Many States are reluctant to take away or even restrict licenses of older drivers, particularly those who live in rural areas, because there may be no transportation alternatives. Societal problems are likely to arise if these people cannot get around. Some key issues are whether communities have the resources to supply specialized transportation to older drivers who lose their licenses and whether these older people are willing to use transit systems in light of limited service and concern for personal safety. In cooperation with the Federal Transit Administration and the Administration on Aging, this research will document a broad array of concerns of older people and prepare a checklist to permit community planners to assess the degree to which there are remedies for these concerns within their community.

Improving Understanding of Vehicle Crashworthiness for Older Occupants

The increased frailty of older persons in crashes raises the question whether increased levels of protection can be obtained with improved vehicle or safety-systems design. As part of crashworthiness research, NHTSA will

analyze crash data to determine the nature of injuries older persons sustain due to restraint systems (lap/shoulder, airbag, etc), compared to injuries sustained by younger people. Since older drivers are more likely to be involved in side impact crashes, these crashes will be investigated to determine the extent to which older occupants are over-involved in fatal injuries.

Identify Causes of Older-Driver Crashes at Intersections

This research will investigate the causes of older-driver crashes at intersections, particularly those involving left turns. Depending on the outcome of these analyses, this will serve as a basis for developing either new advanced-technology in-vehicle devices to assist the driver or training and informational materials for drivers.

Identify Barriers to Physician Referral of Patients for License Reexamination

In most States, laws require physicians to report patients whose medical conditions may make them unsafe drivers. However, there are marked differences in the laws and practices of different States. Different State laws, such as those requiring reporting certain conditions or providing immunity to those reporting, undoubtedly affect the rate of reporting unsafe drivers. This study will investigate the legal, ethical and practical barriers to effective reporting by physicians and explore the relationship between improving safety and improving reporting requirements by physicians. This study will include an investigation of the actual influence on safety and mobility in States with different reporting requirements.

Identify the practical problems in family/friend reporting of functionally limited drivers

There are marked differences across the States in laws requiring families and friends to report a potentially unsafe driver to the licensing agency for reexamination. At least one State does not permit reporting, and others require that individuals called in for reexamination be given the name of the individual reporting them. This study will examine the influence of these differences and recommend steps for improving the process.

Program Development

The following research projects focus on developing strategies for addressing problem areas and generating

suitable countermeasure elements to address specific issues.

Develop Performance Assessment Techniques

Current DMV tests do not detect the conditions that appear to be most problematic. Detecting problem older drivers will require testing for different capabilities under different conditions than are currently in use. Performance tests that closely approximate the driving situations of older drivers and their functional limitations will be developed and validated. Performance tests will also be developed and validated for rehabilitation specialists, particularly in the areas of dementia and perceptual difficulties associated with split-attention tasks.

Many of the functional difficulties that potentially interfere with safe driving are brought about by medical incidents. Testing individuals with limitations from these medical events requires more extensive and complex procedures. Accordingly, performance tests will be designed for those professionals most able to perform the diagnostic testing and training.

Develop Strategies for Meeting Mobility Needs of Older Former Drivers

In cooperation with the Federal Transit Administration and the Administration on Aging, this research will develop strategies for meeting the transportation requirements of older people who can no longer drive. Recognizing that the transportation infrastructures in different communities may be vastly dissimilar, this effort will design informational packages, training materials, program descriptions and guidelines for use at the State and community level.

Develop Improved Intersection Negotiating Practices

Based upon in-depth analyses of the problem, NHTSA will develop either behavioral or human-factor solutions to improving intersection negotiation. The behavioral alternative will develop assessment, informational, and training programs designed to overcome some of the current limitations. The other alternative will apply advanced technology solutions, such as Intelligent Vehicle-Highway Systems (IVHS), to these problems.

Develop Empirical Guidelines for Medical Practitioners

Current medical guidelines for advising older persons about continuing driving are largely based on best professional judgment rather than empirical data relating conditions to safety problems. There is some evidence that existing guidelines may unnecessarily restrict mobility. This research will develop practical guidelines for physicians, based on ongoing NHTSA epidemiological research.

Develop Guidelines for Assisting Older Drivers in Making Decisions About Driving

Following the development of appropriate assessment procedures based on the Agency's epidemiological research, NHTSA will develop a series of guidelines to aid the process of identifying problem older drivers and assisting them to make appropriate decisions regarding driving. Guidelines for older people themselves will provide "self-test" procedures that they may use to determine the extent to which they should limit their driving. Guidelines for families and caregivers will provide methods for dealing with the older driver and for discretely informing the licensing agency of the need to re-examine the functionally-impaired driver. Guidelines for police officers will address the need to report problem drivers and provide methods for identifying drivers who display symptoms of functional limitations or medical conditions that may make them unsafe on the road.

Develop Training and Informational Programs

With the expected increase in the number of older drivers, many of whom will have declining functional capabilities, the Agency will focus on developing new ways of improving their driving. For example, rehabilitation specialists have been teaching stroke patients, head-injured patients, and others to drive again. This study will identify and examine existing training programs to determine the extent to which they actually reduce crashes and help those who should correctly reduce or eliminate their driving. With new technology available, and better understanding of the role of functional limitations on driving, there may be new possibilities to improve both individual and group training of older and functionally impaired drivers. The study will document methods useful for retraining older drivers, recommend improvements to existing programs,

and develop model procedures for use in retraining older drivers.

Advanced Technology

This effort will identify conventional and advanced technology vehicle design features to prevent crashes typical of older drivers. The potential role of advanced technology to extend the driving careers of older people still needs to be identified. Devices and systems that may aid younger drivers may not aid older drivers, and may, in fact, be detrimental to their driving performance. Studies of advanced technology will ensure that proposed systems do not inadvertently degrade older driver safety and performance by overloading their decision-making or informational capacity.

Program Evaluation

The following research projects examine existing programs to document their implementation processes or assess the extent to which they meet their outcome objectives.

Evaluate Safety Benefit of License Re-examination Requirements

Currently, there is lack of agreement on the necessity for the licensing agency to require older drivers, particularly those with clean records, to come to the agency for license renewal. Most older drivers prefer to judge for themselves, or have their physician or family aid them in deciding when, where, or whether they should drive. Many legislators and licensing administrators believe that it is necessary to have older drivers renew in-person so that their behavior can be observed to determine if they need to be examined further. This research will evaluate the outcomes of these alternative licensing procedures.

Evaluate NHTSA/AAMVA Model Driver Screening and Evaluation Program

Many States are eager to institutionalize methods to deal with older drivers. NHTSA's Model Driver Screening and Evaluation Program provides a set of guidelines for consideration and adoption by State motor vehicle administrators. Many of the actions recommended in this program appear to duplicate the actions of self-regulating older drivers. The extent to which this program can detect problem drivers is unknown. This research effort will document implementation procedures

and evaluate the safety consequences of the model program.

Evaluate Safety Outcomes of Self/Community Appraisal of Driving Limitations

To the extent that older drivers regulate their driving to fit their declining capabilities, the driver-licensing system serves as a back-up system or safety net. Under this supposition, the main function of licensing would be to ensure that drivers who continue to drive in situations beyond their capabilities are identified, tested, and, if it is reasonable to do so, licensed for appropriate restricted driving conditions.

The focus of the Agency's research and development effort is to produce guidelines for older drivers, their families, and caregivers to facilitate self-regulation of driving. The more effective these guidelines are in accomplishing their objectives, the more the licensing system functions in its back-up mode. This may result in the need to shift emphasis areas within licensing agencies.

This evaluation will follow the development of the Agency's guidelines and will assess their impact on older-driver safety. This effort will evaluate the guidelines' potential for correctly changing the driving actions of functionally-limited older drivers and determine the subsequent effects of increased self-regulation of older drivers on the roles played by driver-licensing agencies.

Evaluate Programs to Maintain Mobility of Former Drivers

Making the transition from driver to rider status for older persons is not easy. Current programs must be evaluated to help ensure that older people who no longer drive can continue to meet their transportation requirements. NHTSA, FHWA, the Federal Transit Administration, the Administration on Aging, and the National Institute on Aging have jointly proposed programs to address the mobility needs of these former drivers. This effort will evaluate such programs to ensure that they meet the needs of the senior citizen.

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